THE ROLE OF UNEXPECTEDNESS IN ANTECEDENT RETRIEVAL

by

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ABSTRACT

Previous research has demonstrated that antecedent retrieval is influenced by memory-based factors such as elaboration, distance, and causality. It has been demonstrated that content interestingness may influence the degree to which readers attend to information in a passage. Although interestingness can improve student learning or comprehension, it can negatively affect learning outcomes when the interesting information is not the main idea of a text (i.e., seductive details). The present study examined whether a new variable, unexpectedness as a source of interestingness, also influences the process of antecedent retrieval. Participants read passages containing an antecedent and a same-category alternate for an anaphor; the alternate was either expected in the passage context or unexpected. Probe response times demonstrated that expectedness of the alternate influenced antecedent retrieval. The present findings imply that cognitive interest might be another new context-based factor that influences the resonance process besides distance, causality, elaboration, and featural overlap. The results also add to the growing body of literature that supports detrimental effects of seductive details.

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INTRODUCTION

The process of understanding discourse involves constructing mental representations (e.g., Barsalou, 1999; Kintsch, 1988), a process through which readers incorporate and integrate information activated from memory with newly encountered content. For example, to maintain coherence, readers may be required to resolve references to earlier stated information or to information in general world knowledge, or they may need to "fill in gaps" in the narrative by drawing inferences (Cook & O'Brien, 2014; Kintsch & van Dijk, 1978). One view of how these processes occur is the memory-based text processing view, which applies a basic memory retrieval mechanism to reading processes (e.g., Gerrig & O'Brien, 2005; Myers & O'Brien, 1998; O'Brien & Myers, 1999).

One particular area in which memory-based processes have been applied to discourse comprehension is in studies investigating the process through which readers retrieve antecedents from memory upon encountering an anaphoric reference (McKoon & Ratcliff, 1980; O'Brien 1987). Anaphor, or anaphoric phrase, derived from Ancient Greek "anaphora," is the presentation of a word or word phrase such as a repeated noun or proper name (O'Brien, Raney, Albrecht, & Rayner, 1997) that refers to an earlier word or word phrase. For example, an anaphor can be a pronoun (e.g., it) or noun (e.g., house), an anaphoric phrase may be a noun phrase made up of an adjective and a head noun (e.g., the small house), or it can even be a more complex phrase (e.g., …what she bought at the

grocery store). Antecedent refers to the word, word phrase, or clause to which a pronoun or anaphoric phrase refers. For instance, in the sentence, "*Jane wanted to buy this book but Tom didn't like it*," the pronoun "it" is an anaphor and refers to "this book," the antecedent. The past three decades have seen increasingly rapid advances in the studies of anaphor resolution and antecedent retrieval.

Early theories of discourse comprehension focused on how readers extract meaning from a text without recalling the verbatim contents of a text, and on how readers connect incoming information to the ongoing representation in memory without exceeding capacity limitations (e.g., Kintsch & van Dijk, 1978, 1983). Anaphoric references raise a possible complication for this, though, because they often refer to information that is no longer available in memory (e.g., O'Brien, 1987; O'Brien, Shank, Myers, & Rayner, 1988). Readers resolve these references by "searching" memory for antecedents. Within a memory-based text processing view, the process of searching memory involves passive activation of information from memory (see Cook & O'Brien, 2014).

To explain memory activation in this context, O'Brien (1987) first proposed a backward parallel-search model. According to the backward parallel-search model, activation spreads from the information currently being encoded backwards in parallel to previously encountered information, presumably stored in long-term memory. For example, readers may reactivate more recently encountered information first, but activation would eventually spread from that information to content encountered earlier during reading. To test this view, O'Brien (1987) had participants read passages that contained anaphoric references and their antecedents. The antecedent for an anaphoric

reference either appeared early in the passage or late. The results indicated that reading times were shorter for a sentence containing an anaphor that reinstated late antecedents than when it reinstated early antecedents, suggesting that more recently encountered information was activated and integrated faster than information that had been encountered earlier on in the text. O'Brien (1987) argued that the backward parallel search "provides the best account of the nature of the search for an antecedent" (p. 287).

Based on O'Brien's (1987) backward parallel-search model, Myers and O'Brien (1998; O'Brien & Myers, 1999) proposed the resonance model. The primary assumption of the resonance model is that information is activated via a passive retrieval mechanism. When new information is encoded, a signal is sent to all of memory, and information that shares featural overlap will resonate in response. Those concepts that resonate the most are the most likely to be reactivated. The process is passive, in that it occurs without strategic effort on the part of the reader. It is dumb, in that information may be reactivated regardless of whether it is currently relevant to the ongoing discourse model. Finally, it is also unrestricted, in that either information from the explicitly stated text or information from general world knowledge may be reactivated from memory.

Much of the early work on the resonance model focused on antecedent retrieval. Within the assumptions of this model, the reactivation process is influenced by a number of factors. The factors vary according to the way they cue readers to retrieve previous information. Generally, those factors can be divided into two categories: context-based and semantic-based factors. Context-based factors refer to those that involve the contextual cue around the antecedent. For instance, the reactivation process is influenced by the distance (i.e., the number of sentences) between an anaphor and antecedent

(O'Brien, 1987). Antecedents can be retrieved more quickly when an antecedent is close to an anaphor than when the antecedent is far away from the anaphor. Another context-based factor is elaboration. It has been found that elaborated antecedents are retrieved more quickly than unelaborated antecedents, regardless of antecedent distance from the anaphor in the text (O'Brien, Plewes, & Albrecht, 1990).

In contrast, semantic-based factors reflect the conceptual aspects of an antecedent and involve readers' general world knowledge. As a semantic-based factor, featural overlap is the degree to which an antecedent and anaphor share conceptual features in common. With respect to antecedent retrieval, this means that time to reinstate an antecedent should be affected by the degree of featural overlap between the anaphor and antecedent. This was investigated by Garrod and Sanford (1977), who had participants read sentences such as, "*A robin/goose would sometimes wander into the house. The bird was attracted by the larder.*" In this example, "robin" is considered as a high conjoint frequency exemplar of the category "birds," whereas "goose" is a low conjoint frequency exemplar. Garrod and Sanford found that upon reading "bird" in the second sentence, subsequent reaction times to a probe of "robin" were faster than for "goose," presumably because "robin" shared more features in common with "bird" and was reactivated more quickly in response to the anaphor.

Featural overlap is a critical assumption of the resonance model. The reactivation process would not occur if any particular antecedent does not share features with its anaphor (O'Brien & Myers, 1999). Thus, featural overlap is always considered as a critical factor along with other factors that are examined in a study. O'Brien et al. (1997) examined the role of lexical repetition and distance effects in antecedent retrieval. They

designed passages in which there were three possible antecedent conditions (i.e., conceptually identical, lexically identical, or control), and three levels of distance between the antecedent and anaphor in the text (i.e., near, moderate, or distant). For example, in the conceptually identical condition, the anaphoric phrase was “baby clothes” and the antecedent was “baby clothes.” In the lexically identical condition, the anaphoric phrase was “winter clothes” so that it was lexically identical to but conceptually different from the antecedent (i.e., the baby clothes). In the control condition, the target antecedent was removed. In all three conditions, participants were required to name the adjective modifier of the target antecedent (e.g., baby). O’Brien et al. found that naming time was significantly faster in the conceptually identical condition than in either the lexically identical or control conditions. This indicated that the conceptual similarity between the anaphor and the antecedent plays an important role in the antecedent reactivation process. They also found that there was no significant difference for the naming time in any of the three conditions as the distance between an anaphor and its antecedent increased (i.e., the distant condition).

Given the unrestricted nature of the activation process involved in antecedent retrieval, it is possible that concepts that are not present in a text can also be reactivated during reinstatement if sufficient context supports those concepts. For example, O’Brien and Albrecht (1991) used passages like the example in Table 1, in which the contexts varied with respect to whether they supported an antecedent that was low-related to the context (e.g., cat) or high-related to the context (e.g., skunk). This was followed by a demand sentence containing an anaphoric phrase (e.g., asked what had run in front of her car). O’Brien and Albrecht then presented naming probes for either the low-related

Table 1
Sample passages with conditions
in O'Brien and Albrecht's (1991) Experiment 1

Context	Antecedent type	
	High related	Low related
High	Mary was driving in the country one day when she smelled a terrific odor. Suddenly a small black *skunk* with a white stripe down its back ran in front of her car. Mary knew she couldn't stop in time. However, she hoped she had managed to miss the animal and continued on her way. After a while, she noticed she was low on gas. While at the gas station, the attendant asked her what had run in front of her car.	Mary was driving in the country one day when she smelled a terrific odor. Suddenly a small black *cat* with a white stripe down its back ran in front of her car. Mary knew she couldn't stop in time. However, she hoped she had managed to miss the animal and continued on her way. After a while, she noticed she was low on gas. While at the gas station, the attendant asked her what had run in front of her car.
Low	Mary was driving in the country one day and she gazed at the setting sun as she went. Suddenly a small black *skunk* with a long furry tail ran in front of her car. Mary knew she couldn't stop in time. However, she hoped she had managed to miss the animal and continued on her way. After a while, she noticed she was low on gas. While at the gas station, the attendant asked her what had run in front of her car.	Mary was driving in the country one day and she gazed at the setting sun as she went. Suddenly a small black *cat* with a long furry tail ran in front of her car. Mary knew she couldn't stop in time. However, she hoped she had managed to miss the animal and continued on her way. After a while, she noticed she was low on gas. While at the gas station, the attendant asked her what had run in front of her car.

antecedent (e.g., cat), or the high-related concept (e.g., skunk). They found that "skunk" was activated in memory, even when the text contained an explicit reference to "cat." Moreover, if the context supporting the unnamed concept was sufficiently high, the unnamed concept was actually instantiated in place of the correct antecedent.

O'Brien and Albrecht's (1991) findings are consistent with the view that activation spreads through an associative network, such that any related concepts, which

may include inappropriate candidate antecedents, have the potential to be activated. Corbett and Chang (1983) found that when participants read sentences like "*Jack threw a snowball at Phil, but he missed,*" the reading time on the pronoun "he" was slower compared to when participants read sentences such as "*Mary and Bill went to the store and he bought a quart of milk.*" The reason is that in the first sentence "he" would resonate with both "Jack" and "Phil," but in the second sentence, "he" only resonates with "Bill." In a follow-up study, Corbett (1984) demonstrated that a semantically related distractor antecedent lengthened reinstatement times. Readers were presented with passages containing an anaphor (e.g., frozen vegetable), an antecedent (e.g., frozen asparagus), and a distractor antecedent (e.g., fresh corn). Corbett found that the presence of a distractor antecedent (e.g., fresh corn) could increase processing time for an anaphoric noun phrase (e.g., frozen vegetable) because "vegetable" presumably resonates with and activates both asparagus and corn, leading to difficulty in reinstating the appropriate antecedent (e.g., frozen asparagus). Although related but inappropriate candidate antecedents may become active during the search process, they are quickly suppressed or inhibited (O'Brien, Albrecht, Hakala, & Rizzella, 1995; Wiley, Mason, & Myers, 2001).

Although it has not been specifically investigated with respect to the resonance model, Myers and O'Brien (1998; see also Gerrig & O'Brien, 2005) argued that the degree of attention paid to the information in working memory can affect the signal to memory, and thus the information retrieved. Birch and Garnsey (1995) used cleft-sentence structures to focus reader attention on specific words in a sentence, such as, "It was the lion that…" and "There was this caucus that…" They found that memory for

focused content was significantly better than in a control condition in which no such syntactic focusing device was used. Birch and Rayner (1997) used similar sentences and tracked readers' eye movements to determine whether syntactic focus increases attention (i.e., fixation time) on words. They found that participants fixated longer on focused regions than on unfocused regions; they argued that the recall benefits for focused content observed by Birch and Garnsey were due to increased attention on focused content. Furthermore, Almor (1999) demonstrated that participants read an anaphor more quickly when its antecedent was focused than when it was unfocused (see also Cowles & Garnham, 2005). Based on the studies just described, it appears that focusing devices (e.g., cleft sentence structures) may initially draw a reader's attention to a word or phrase, and that this increased attention facilitates encoding and thus subsequent retrieval.

The previous paragraph discussed how syntactic focus could orient readers' attention to specific words in a sentence. A broader question concerns the factors that influence how readers differentially allocate their attention to information in a text. According to Meyer (1975), important information refers to the content that represents the main idea of a text and that is interspersed throughout the passage, and recent evidence suggests that individuals spend more time reading important information than unimportant information (Britton, Meyer, Simpson, Holdredge, & Curry, 1979; Cirilo & Foss, 1980; Just & Carpenter, 1980; Rothkopf & Billington, 1979). For example, Cirilo and Foss (1980) designed an experiment to examine reading time on important details in story contexts. For example, in their materials, the sentence, "He could no longer talk at all" was embedded in different story contexts; it played an important role in one story context but an inferior role in another story context. They found that the average reading

time for the target phrase was slower in the "important" context condition than in the "inferior" context condition.

Another way of manipulating the importance of information in a text is to do so with external material that emphasizes specific information. For example, Anderson (1982) proposed three methods of inducing importance: use of adjunct questions, the assignment of perspectives prior to reading, and the interestingness of the reading material. Reynold, Standiford, and Anderson (1979) investigated whether readers pay more attention to information in a text that is relevant to adjunct questions. They measured the distribution of reading time when subjects read a text with and without questions, and found that those who read with information-related questions spent more time than those who read without questions. Pichert and Anderson (1977) investigated whether readers allocate their attention differently in a text, dependent upon their perspective. They had participants read a narrative about two boys visiting one of the boys' homes either from the perspective of a homebuyer or a burglar. They found that the individuals in the "homebuyer" condition recalled more homebuyer facts like the properties of a house (e.g., a leaking roof) whereas the individuals in the "burglar" condition recalled more burglar facts like the possessions of a house (e.g., a color TV set). Given that the text was identical across conditions, Pichert and Anderson concluded that the readers' perspectives influenced recalled content.

The third variable proposed by Anderson (1982), interest, is the focus of this study. According to Anderson, the interestingness of the reading material should influence both attention and memory. Hidi (1990) pointed out that interest is an integral part of cognition and contributes to how readers select certain types of information over

others. Before discussing the research on interestingness, it is necessary to clarify the distinction between interestedness and interestingness. Interestedness, or topic interest, refers to topics that readers find interesting, based on their preference for or domain knowledge about a topic (Campion, Martins, & Wilhelm, 2009). For example, an ecologist might find a text on water circulation interesting, because he/she is curious about or fascinated by that topic. Previous studies demonstrated that the increase of topic interest could be accounted for by topic-related knowledge (e.g., Boscolo & Mason, 2003; Tobias, 1994). In contrast, interestingness, also known as cognitive interest or text-based interest, raises reader's interest for understanding a text and results from the cognitive processing of the information that a text provides no matter what topic of the text is or presumably regardless of readers' domain-specific knowledge (e.g., Campion et al., 2009; Hidi & Baird, 1986; Kintsch, 1980). Readers, for instance, may be interested in a science fiction story because it includes scenarios that are inconsistent with their general world schemas and that they find entertaining. The present study focuses on interestingness in narratives.

To test the idea that interestingness can affect later memory for text contents, Wade and Adams (1990) designed two formats of the same biographical text: one was regular manuscript form and the other was divided into segments. They had participants rate segments of the text for both interest and importance, and based on these ratings, Wade and Adams identified four qualitatively distinct categories for text segments: high importance/high interest, high importance/low interest, low importance/ high interest, or low importance/low interest. For example, in the high importance/high interest context, it explained how the protagonist of a story succeeded and what historical suspense or

unexpected events affected that; in the high importance/low interest context, sentences were highly relevant to the main ideas of the text but had no direct emotional appeal and did not include the conditions of unexpectedness. In the low importance/high interest context (seductive details), sentences were inherently interesting but irrelevant to the important/main ideas of the text. In the low important/low interest context, readers would be encountered with minor details irrelevant to the main ideas that also have no inherent interest. In the second experiment, Wade and Adams randomly required participants to take a recall test either immediately after reading or after a one-week delay. Their results indicated that information that had been previously rated as interesting regardless of importance was recalled best; in contrast, details supporting the main ideas, which had been rated as important regardless of interestingness, were least memorable.

Several other researchers have also examined factors that contribute to or influence interestingness of text content. For example, Schank (1979) argued that unexpected events can elicit cognitive interest. Texts that violate schema-congruent expectations may be more interesting than those that uphold current schema-based expectations. Recently, Campion et al. (2009) conducted three experiments to investigate the relationship between uncertainty and cognitive interest. For instance, three experimental conditions were used to describe the protagonist's characteristics with respect to a later target action: consistent, inconsistent, and neutral versions. In the consistent version, "*Sophie took no care about her appearance and had no interest in clothes*" is consistent with the subsequent target sentence, "*She put on a crumpled dress and a pair of old shoes. Without brushing her hair, she picked up an ugly handbag and went out.*" In the inconsistent version, however, inconsistent outcomes in stories were

created to cause uncertainty. For example, "*Sophie liked to look attractive and to wear pretty clothes*" is inconsistent with the subsequent target sentence, "*She put on a crumpled dress and a pair of old shoes. Without brushing her hair, she picked up an ugly handbag and went out.*" Sophie's characteristics are inconsistent with the events in the target sentences and the reader may be uncertain about why Sophie behaved this way. Participants were required to read and rate the interest for the text events simultaneously. The results showed that the mean reading times for the target sentences were longer and the text interest ratings were higher when the text contained an inconsistency than when it did not. This supported the Campion et al. hypothesis that inconsistent actions are more interesting than consistent and neutral actions due to the level of uncertainty they produce.

It has been shown that importance and interest of a text draw readers' attention during reading. However, what happens when the interesting information is not important to the main idea in a text? Previous studies have demonstrated that the presence of seductive details (interesting, but unimportant information) in a text can result in poor learning outcomes (e.g., Harp & Mayer, 1998; Schraw, 1998; Wade, Schraw, Buxton, & Hayes, 1993). Garner, Gillingham, and White (1989) found that seductive details affected readers' recall of main ideas from an expository text. Readers who were asked to read paragraphs containing seductive details recalled less information related to the main idea of the text than those who read passages without seductive details (see also Harp & Mayer, 1998).

Similarly, Lehman, Schraw, McCrudden, and Hartley (2007) examined effects of seductive details on text recall, understanding, and reading time for a technical, scientific text. Their participants read a 50-sentence, 967-word passage adapted from Harp and

Mayer's (1998) seductive details text. Participants were randomly assigned to one of two conditions: a control condition in which the passage only included base text (i.e., nonseductive sentences in which some sentences included main ideas), and an experimental condition in which the passage was comprised of 26% seductive details (i.e., seductive details text). Thus, the independent variable was text condition with two levels: base text (741 words with no seductive details) and seductive details text (961 words with base text and seductive details). Consider, for example, in a base text about the process of lightning, the sentence "*At this altitude, the air temperature is well below freezing, so the water droplets become tiny ice crystals.*" In this sentence, there are two idea units: "At this altitude, the air temperature is well below freezing" and "so the water droplets become tiny ice crystals." In contrast, the seductive details sentence, "*Golfers are prime targets of lightning strikes because they tend to stand in open grassy fields, or to huddle under trees*" contained two idea units: "Golfers are prime targets of lightning strikes" and "because they tend to stand in open grassy field, or to huddle under trees." These facts are interesting, but they do not provide any important information about the process of lightning. Lehman et al. measured reading time (i.e., the mean time spent reading each word in the base text sentences), recall of text ideas, holistic understanding score (i.e., a rating on a scale of 1 to 5 used to holistically judge participants' responses), and total claims scores (i.e., a rating system used to reflect the numbers of participants' legitimate claims that support their answers to the questions). They found that participants reading the seductive details version spent less time reading the base text sentences when seductive details were included than those reading the base text alone and performed more poorly on recall tests and holistic understanding than the participants who read the

base text alone. Consistent with earlier work, Lehman et al. demonstrated that the seductive details of a scientific text distracted readers from main ideas.

Harp and Mayer (1998) offered three hypotheses to explain the seductive details effect. First, they argued that seductive details distract readers from attending to relevant information (distraction hypothesis). If this is correct, readers who receive guidance toward main ideas should be less influenced by seductive details. Second, seductive details disrupt comprehension, leading to incoherent representations of the causal connections between ideas in a text (disruption hypothesis). According to this hypothesis, reading a passage with organizational signals should result in a reduction in the seductive details effect. Third, Harp and Mayer argued that diversion occurs when readers build a mental representation around the seductive details instead of around the important main ideas (diversion hypothesis). According to that idea, reading the passage with the seductive details at the beginning of the passage should produce a stronger seductive details effect than reading the passage with seductive details at the end.

Based on these hypotheses, Harp and Mayer (1998) conducted four experiments in which the one group read the base passage and another group read a passage containing seductive details. First, in their test of the distraction hypothesis, they found no significant difference between the group reading the passage with highlighting structurally important ideas and the group reading the passage without highlighting, suggesting that the seductive details effect is not due to a failure to select main ideas. For their test of the disruption hypothesis, Harp and Mayer found that organizational signals did not appear to help readers build mental representation of a text. Finally, in their test of the diversion hypothesis, they reported that readers who received seductive details at the

beginning of the passage could recall and transform information as well as those reading the passage without the seductive details. However, readers recalled more seductive details and used them as the organizing schema when the details were placed at the beginning of the passage than when placed at the end of the passage. Thus, they suggested that the seductive details effect could be reduced if reader avoided the activation of erroneous prior knowledge.

In addition, Rey (2012) recently conducted a meta-analysis on the seductive details effect. Based on his findings, he proposed six explanations of the seductive details effect: overloading working memory, attention distraction, schema interference, coherence disruption, motivational aspects, and perceptual load, in which he focused more on the former four explanations than the last two explanations that have just been supported by a few empirical evidence. The three explanations, attention distraction, schema interference, and coherence disruption, are similar to Harp and Mayer's distraction, diversion, and disruption hypotheses. Rey found that some studies supported the four explanations (i.e., working memory, attention distraction, schema interference, and coherence disruption) while others contradicted them. Proponents of overloading working memory explanation showed that high-interest details overloaded readers' working memory, resulting in less cognitive processing capacity for important information (e.g., Mayer, Griffith, Jurkowitz, & Rothman, 2008). However, Sanchez and Wiley (2006)'s results of the seductive details effect could not be explained by overloading working memory and they argued that their results might be better explained by attention distraction. According to attention distraction hypothesis, seductive details result in attention distraction because they draw more attention than nonseductive details

do. Lehman et al. (2007) found that participants who received the base text with seductive details paid less attention to the base text than participants who just received the base text. Lehman et al. pointed out that attention distraction was due to a break in text coherence (i.e., coherence disruption). McCrudden and Corkill (2010) replicated the Lehman et al. findings and also found that participants spent more reading time on the base text when it was following seductive details than when it was not. This implies that important information was disrupted by seductive details and readers construct incoherence representations of the main ideas of a text due to the disruption. As a result, readers utilize inappropriate schema to organize main ideas of a text (e.g., Harp & Mayer, 1998). Rowland, Skinner, Davis-Richards, and Saudargas (2008) found that participants who read a seductive detail text performed better on a retention test when they received the seductive detail after the main text than when they received the seductive detail before the main text. Although there is not a consensus among theorists for a single explanation for the seductive details effect, it is clear that seductive details can have a strong and detrimental effect on learning from text. Most research on the seductive details effect has focused on expository texts. This complicates investigating underlying processes, because readers may not have the appropriate background knowledge to fully comprehend the information in the text. In addition, most studies, with a few exceptions, have focused on offline measures of comprehension, such as performance on a recall test. The goal of this study was to address how seductive details influence processing of information in narrative texts; this was investigated with several online measures of reading comprehension.

The Present Study

The first part of the introduction discussed the research on antecedent retrieval that has focused on memory-based factors, such as elaboration, recency, and number of distractors (see Myers & O'Brien, 1998; O'Brien & Myers, 1999). However, as noted by Myers and O'Brien (see also Gerrig & O'Brien, 2005), the level of attention paid to specific content may also influence its retrieval. The latter part of the introduction focused on the seductive details effect, in which it has been demonstrated that content interestingness may influence the degree to which readers attend to information in a passage. Although interestingness can improve student learning (Hidi, 1990; Hidi & Harackiewiez, 2000) or comprehension (Hidi, 1986; Renninger, 1988), it can negatively affect learning outcomes when the interesting information is not the main idea of a text (i.e., seductive details). However, as noted at the end of the previous section, most research on seductive details has been conducted with expository texts and with offline measures (e.g., recall, ratings), without as much examination of how these details affect online processing.

The aim of this study was to extend research from previous studies and deepen the understanding of how seductive details in narrative text influence (1) online processing of the seductive and nonseductive information and (2) subsequent retrieval of that seductive and nonseductive information when cued via an anaphoric reference. As argued by Campion et al. (2009), the degree to which information in a text is unexpected may influence its interestingness, or "seductiveness." The definition of "seductive" adopted in the present study focused on the degree to which an object was expected in a given scenario; this was verified in a rating study.

Participants read passages comparable to the example presented in the Appendix. After a brief introduction that establishes a given scenario, two objects (one antecedent and one alternate) were described. One was an object typically found in the story setting and was referenced later in the passage (candidate antecedent). The other object served as a distractor (alternate antecedent) to the candidate antecedent; this distractor was either something typically found in the setting (nonseductive alternate) or something unexpected in the setting (seductive alternate). For example, in the passage in the Appendix, sheep is always the antecedent referenced in the target sentence. The alternate concept, lion, comes from the same category as sheep (i.e., animal), either presented in an uninteresting (nonseductive) setting (e.g., zoo), or in an unexpected and therefore more interesting (seductive) context (e.g., barn). These concepts were backgrounded, and then a target sentence that reinstated antecedent (e.g., Jose's brother asked him what type of animal he had fed) was presented. In the experiment, participants were asked to provide a speeded recognition response to a probe that reflected either the antecedent (i.e., sheep) or the alternate concept (i.e., lion). Previous researchers have used this recognition probe paradigm to study antecedent retrieval (Dell, McKoon, & Ratcliff, 1983; McKoon & Ratcliff, 1992; O'Brien, Duffy, & Myers, 1986) and have found that faster response times are indicative of higher activation levels in memory (e.g., McKoon & Ratcliff, 2015). This methodological approach allowed us to answer the first two research questions:

1. Does the seductiveness of an alternate concept in a narrative affect later reactivation of a reinstated antecedent?
2. Does the seductiveness of an alternate concept in a narrative affect later reactivation of that concept?

Previous research on the seductive details effect demonstrated that seductive information may distract readers' attention from important information, such that the important information may not be encoded as deeply or recalled as well in a subsequent test (Lehman et al., 2007; Sanchez & Wiley, 2006). If this is true, we would expect that following reinstatement of the candidate antecedent, response times to the probe of the candidate antecedent would slower in the seductive condition than in the nonseductive condition. Meanwhile, the seductive nature of the detail is assumed to enhance encoding of the seductive information. If this is true, participants would make more errors when they responded to alternate antecedent in the nonseductive condition than in the seductive condition.

In previous research on antecedent retrieval, O'Brien (1987) found that more recently encountered antecedents were reactivated more quickly upon reinstatement than less recently encountered antecedents. However, subsequent experiments revealed that these distance effects disappeared if the distant antecedent was more elaborated in the text than the recent antecedent (O'Brien et al., 1990; O'Brien & Myers, 1987). It is possible that in the present study, the order in which the antecedent and the alternate antecedent are presented would interact with the seductive nature of the alternate antecedent. This led to the third research question:

3. Does the order of presentation of the alternate and the mediate the seductive details effect?

To address this question, half of the materials had the antecedent presented first with the alternate presented second, and the order of the antecedent and the alternate was reversed in the other half of the materials.

METHOD

Previous studies have demonstrated that readers recall more interesting, or seductive, details faster than nonseductive details (e.g., Bartsch & Cobern, 2003; Harp & Mayer, 1998). In addition, researchers have argued that unexpectedness is one source of cognitive interest (Hidi, 1990; Kintsch, 1980; Schank, 1979; Stangor & McMillan, 1992). This experiment investigated whether the "seductiveness" of details in a narrative would affect later reactivation of content. Previous studies have demonstrated "seductiveness" of detail affects later recall of information, but no studies have examined this with online measures of activation for narratives.

As described earlier, texts contained an antecedent (that was subsequently reinstated) and an alternate concept. The alternate was either seductive in nature (unexpected in the narrative context) or nonseductive (expected in the narrative context). After reading a sentence that reinstated the antecedent, participants were asked to respond to a probe word that reflected either the antecedent or the alternate. If the presence of seductive details (i.e., seductive alternate) in a text affects subsequent activation of the antecedent, response times for the antecedent (e.g., sheep) should be slower when the alternate (e.g., lion) is presented in the seductive context than in the nonseductive context (Research Question 1). In addition, if the seductiveness of information affects subsequent reactivation of that information, error rates to the alternate should be higher when it is nonseductive than when it is seductive (Research Question 2). To ensure that the distance

between the antecedent (or the alternate) and the reinstated sentence was not a confounding variable, half of the passages presented the antecedent before the alternate, and half presented the alternate before the antecedent; this enabled us to test for any interaction between distance and seductive information (Research Question 3).

Participants

A total of 80 participants of University of Utah undergraduates were recruited for this study from the Educational Psychology Subject Pool. Participants received partial course credit for their involvement in the study. All participants were native English speakers.

Materials

Fifty-six experimental passages were constructed, consisting of 28 experimental passages into which the 28 sentences we selected from the rating study were inserted, and 28 "filler" passages that were designed to mask the purpose of the experiment. In the beginning of each passage, there were two to three introductory sentences. The next section of the passage presented two concepts: antecedent, and an alternate. The alternate was either unexpected in the narrative context (seductive) or expected (nonseductive). In half of the passages, the antecedent was presented first, followed by the alternate; this order was reversed in the other half of the passages. Following this section, two to three sentences that served to background the antecedent were presented. This was followed by a sentence that reinstated the antecedent. Participants were then presented with a one-word probe that reflected either the antecedent or the alternate. The probes to the

experimental passages were always true while the probes to the filler passages were always false. The probe was followed by a comprehension question that did not focus on the probed content (see an example presented in Appendix).

Rating Study – Unexpectedness

A rating study was conducted in order to ensure that the two alternate conditions (i.e., seductive vs. nonseductive) differed with respect to the unexpectedness of the alternate concept in the passage context. We asked 14 University of Utah undergraduates who did not participate in the reading time/recognition experiment to engage in a rating study. Participants were presented with the sentences from the context section that presented the antecedent, and were asked to rate them on their unexpectedness on a 5-point scale (where 1 = "Totally Unexpected" and 5 = "Totally Expected"). For example, participants were asked to rate the likelihood that the word (e.g., the alternate "lion") could be expected in the given context (e.g., Jose looked into the stall of the barn, and in the corner was a curled up lion). Two materials sets were constructed, such that each set contained 38 sentences with an equal number of sentences in two conditions: nonseductive and seductive. Across all sets, each sentence appeared in each condition. All analyses reported are significant at the .05 alpha level unless otherwise indicated; t_1 refers to tests against an error term based on subject variability and t_2 refers to tests against an error term based on item variability. As anticipated, participants rated the sentences as more unexpected in the seductive condition (M=1.79, SD=.75) than in the nonseductive condition (M=4.26, SD=.52), $t_1(13)$=24.07, $t_2(37)$=19.59. From the larger set of 38 sentences, we selected 28 items that were inserted into our 28 experimental

passages; the pattern for this subset of 28 items reflected the same overall pattern of ratings that was observed in the larger set (*M*=1.54, *SD*=.53 for the seductive condition and *M*=4.34, *SD*=.5 for the nonseductive condition).

Design and Procedure

The experiment was a 2x2x2 mixed factorial design with position (alternate first versus alternate second) as between-subjects variable and text type (nonseductive versus seductive) and probe type (probe alternate versus probe antecedent) as within-subjects variables. Participants were randomly assigned to one of the eight sets of materials. The dependent variables were reading time for the reinstatement sentence, and recognition time and error rates for the probe. Each participant was run individually in a 1-hour experimental session. All materials were presented on a video monitor controlled by a Micron 500MHz microcomputer. Participants completed an informed consent form and were instructed that they would be reading passages at their own normal, comfortable reading rate and answering comprehension questions. When participants indicated that they understood the instructions, they pressed the space bar, and the first trial began. Each trial began with the word "READY" at the center of the display. When participants were ready to read a passage, they pressed the space bar. They advanced through the passage one line at a time, using the space bar. Comprehension time for a particular line was measured as the time between key presses. After the last line of the passage disappeared, this was followed by a mask "XXXXX" for 500ms and this was replaced by a recognition probe. Participants were instructed that they were required to verify whether the word had appeared in the passage they just read as quickly but as accurately

as possible by pressing “yes” or “no” key. At the end of each passage, a yes/no comprehension question appeared and participants had to press either a “yes” or “no” key after the recognition probe, ensuring that they were reading for comprehension. At the beginning of the experiment, participants read three practice passages to ensure that they thoroughly understood the instructions and procedure of the experiment

ANOVA Results and Discussion

Overall, accuracy rates on comprehension questions were high (>85%). The reading times for the line requiring reinstatement of the antecedent of each passage and the time to recognize the probe were recorded. Reading times and recognition times that were three standard deviations from the mean for a subject were eliminated from the analyses. This eliminated less than 2% of the data. F_1 and t_1 are presented as the tests against an error term based on subject variability and F_2 and t_2 are presented as the tests against an error term based on item variability. All analyses reported are significant at the .05 alpha level unless otherwise indicated. In order to test the effects of the variables of interest, an independent 2x2x2 mixed-designs ANOVA was performed for each dependent variable.

Reading times. The mean reading times (milliseconds) for the reinstatement sentences are presented in Table 2. There were no reliable differences in the time to read the reinstatement sentence as a function of either position or seductiveness conditions, all *Fs* <1. In addition, no any interactions approached significance, all *Fs* <1.

Recognition times. The mean recognition times for the experiment are presented in Table 3. Neither the main effect of position condition nor the interaction of position

Table 2
Mean reading times (and standard deviations) in milliseconds for Reinstatement Sentences as a Function of Text Type and Position in the Experiment

	Position		
Text Type	Alternate First	Alternate Second	Mean
Nonseductive	1537.54(*351.14*)	1548(*260.53*)	1542.8
Seductive	1528.27(*362.27*)	1520.12(*281.24*)	1524.2
Mean	1532.9	1534.1	

Table 3
Mean recognition times (and standard deviations) as a function of Text Type and Probe Type in the Experiment

	Text Type	
Probe Type	Nonseductive	Seductive
Antecedent	1186.24 (*259.47*)	1227.58 (*256.5*)
Alternate	1308.84 (*248.64*)	1330.46 (*267.29*)

Note. Standard deviations are in parentheses.

condition with the other two conditions approached significance, all *Fs* <1. Thus, all remaining analyses were pooled across the two alternate conditions. There was a significant main effect of Probe Type. The reinstated antecedent was recognized significantly faster than the alternate, $F_1(1,78)=40.36$, *MSE*=25193.75, partial $\eta^2= .34$; $F_2(1,27)=20.03$, *MSE*=36546.95, partial $\eta^2= .43$. The main effect for Text Type was also significant. Recognition times were longer in the seductive condition than in the nonseductive condition, $F_1(1,78)=6.34$, *MSE*=12513, partial $\eta^2= .075$; $F_2(1,27)=4.75$, *MSE*=17077.27, partial $\eta^2= .15$. Planned comparisons confirmed that this difference was primarily due to slower recognition times for the antecedents when the alternate was seductive than when it was nonseductive, $t_1(79)=-2.1$, $p=.04$; $t_2(27)=-2.26$, $p=.03$. There was no significant difference in the time to recognize the alternate as a function of seductiveness, both *ts* < 1. No interactions approached significance, all *Fs* <1.

Error rates. Neither the main effect of position condition nor the interaction of position condition with the other two conditions approach significances, all *Fs* <1. Thus all remaining analyses were pooled across the two alternate conditions. The Probe Type significantly affected error rates: $F_1(1,78)=49.22$, $MSE=.08$; partial $\eta^2=.39$; $F_2(1,27)=28.85$, $MSE=.09$, partial $\eta^2=.52$. Error rates were higher when participants were required to recognize the alternate than when they were required to recognize the antecedent. The main effect of Text Type was marginal in the subject analysis: $F_1(1,78)=3.15$, $MSE=.02$, $p=.08$; and it was not significant in the item analysis, $F_2<1$. The Probe Type x Text Type was marginal: $F_1(1,78)=3.81$, $MSE=.03$, $p=.055$; $F_2(1,78)=2.87$, $MSE=.02$, $p=.096$. Planned comparisons confirmed that participants made more errors when they were required to recognize alternate in the nonseductive condition than in the seductive condition, $t_1(79)=-2.46$; $t_2(27)=-3.97$. There was no significant difference in the error rates for the candidate antecedents across two alternate conditions, both *ts* < 1.

The recognition times confirmed that participants were reinstating the antecedent: the reinstated antecedent was recognized significantly faster than the alternate, regardless of whether the alternate was seductive or not. More interesting is the fact that recognition times also showed the seductive details effect; recognition times for the antecedents were slower when the alternate antecedent was presented in the seductive condition than when the alternate was presented in the nonseductive context. The passage context also affected error rates for the alternate; participants made more recognition errors for the alternate when it was presented in a nonseductive context than when it was presented in a seductive context. Further discussion of this effect will be postponed until the General Discussion.

Results of Fitting the Linear Mixed-Effects Model (LMM) Using lmer

The reaction time (RT) data were also analyzed by linear mixed-effect model (LMM) analyses using the R statistical computing software, version 2.15.2 (R Development Core Team, 2012). The lmer program of the lme4 package (Bates, 2005; Bates, Maechler, & Dai, 2009; Bates & Sarkar, 2007) provides reliable parameter estimation and model evaluation for the LMM. LMM has recently been an alternative approach for replacing the traditional F_1/F_2-ANOVA in the field of psychology and linguistics besides many areas of science, medicine, and engineering (Baayen, 2008; Baayen, Davidson, & Bates, 2008). The studies in those fields usually have both experimental items and participants of which the spaces are too large to be an exhaustive list (Baayen et al., 2008). The advantage of LMM is that both items (i.e., experimental passages in the present study) and participants are specified as random variables, varying in mean RTs, and LMM is able to model crossed participant and item effects simultaneously.

Recognition times. Since we did not find any significant effects for reading time in the present study, the main analyses were only conducted on the response time and the error rates. The independent variables were Text Type, Position, and Probe Type. For the response time, the model for Probe Type showed that the response times for the reinstated antecedent were faster than for the alternate (β = -115.47, SE = 15.33, t = -7.53, p <.000). The model for Text Type showed that response times for probes were longer when the alternate appeared in the seductive condition than in nonseductive condition (β = 32.37, SE = 15.34, t = 2.11, p <.05). Planned comparisons confirmed that the recognition times of the antecedents were slower when the alternate appeared in the

seductive condition than when it appeared in the nonseductive condition, (β = -44.06, *SE* =21.62, *t* =-2.038, *p* = .04). There was no significant difference in the time to recognize the alternate antecedents across two text type conditions, *t* < 1. The main effect of Position did not reach statistical significance (β = 3.73, *SE* = 49.91, *t* =.08, *p* = .94).

Error rates. For the error rates, the model for Probe Type showed that the error rates were higher for the alternate than for the antecedent (β = .22, *SE* = .02, *t* = 9.76, *p* < .000). Neither the main effect of Position nor the main effect of Text Type approached significance, all *ts* <1. No interactions approached significance for either recognition times or error rates, all *ts* <1. The LMM results are consistent with the traditional ANOVA results.

GENERAL DISCUSSION

The goal of the present experiment was to address three main assumptions: (1) the seductiveness of an alternate concept in a narrative affects subsequent reactivation of a reinstated antecedent, (2) the seductiveness of an alternate concept in a narrative affects later reactivation of that concept, and (3) the order of presentation of the antecedent and alternate concepts mediates the seductive details effect. Previous studies on the seductive details effect have focused on expository texts with offline measures such as recall or ratings (e.g., Garner et al., 1989; Harp & Mayer, 1997, 1998; Lehman et al., 2007; Rey, 2011; Sanchez & Wiley, 2006). It is not clear whether the seductive details effects affect online processing during reading narratives.

Previous research on cognitive interest has found that readers recalled more interesting details than uninteresting details. On one hand, interesting contents improved students' learning outcome only if the interesting information was related to important information or main ideas (e.g., Ainley, Hidi, & Berndorff, 2002; Harp & Mayer, 1997; Schiefele, 1991; Wade & Adams, 1990). On the other hand, interesting contents could be seductive details that can distract readers' attention from memory for important information and affect later memory for the main ideas (e.g., Garner et al., 1989; Harp & Mayer, 1998; Lehman et al., 2007). As discussed in the introduction, previous studies of online processing during reading have demonstrated that elaboration of an alternate concept can influence the subsequent reactivation of a candidate antecedent (e.g.,

O'Brien, 1987; O'Brien et al., 1990, 1995). Taken together, this study questioned whether the seductiveness (i.e., unexpectedness) of the alternate would also influence antecedent reinstatement.

First, consider the recognition times for the reinstated antecedent. Consistent with previous studies on antecedent retrieval (e.g., Dell, McKoon, & Ratclif, 1981; O'Brien, 1987; O'Brien & Albrecht, 1991; O'Brien & Myers, 1985; O'Brien et al., 1995), participants were faster to recognize the reinstated antecedent than they were to recognize the alternate. The more interesting test was whether seductiveness of the alternate concept affected reactivation time for the reinstated antecedent., Recognition times for the reinstated antecedent were longer when the alternate was seductive than when it was not. The observation of a processing cost in the seductive condition is consistent with the resonance model proposed by Myers and O'Brien (1998; O'Brien & Myers, 1999). The primary assumption of the resonance model is that information is activated via a passive retrieval mechanism. This reactivation mechanism is influenced by factors such as distance (context-based), elaboration (context-based), and featural overlap (semantic-based). When new information is encoded, a signal is sent to all of memory. Those concepts that resonate the most are those that are strongly related to the current information and the most likely to be reactivated, regardless of its source. According to the resonance model, when the reinstated sentence is encoded, a signal would be sent out to all of memory, and any information sharing features in common with the contents of this statement should resonate and be reactivated. The candidate antecedent and the alternate antecedent both shared features with the contents of the reinstated sentence; as a result, both alternate antecedent and candidate antecedent were reactivated. Presumably,

seductive alternates may have been attended to, and therefore encoded, more deeply than nonseductive alternates when initially encountered in the text, resulting in greater competition during reinstatement than nonseductive alternates. When the reinstatement sentence subsequently referenced the antecedent, seductive alternates may have led to greater competition for activation than nonseductive alternates; participants were slower to recognize antecedents when the alternate was seductive than when it was nonseductive. The results for the reinstated antecedent are also consistent with the attention distraction hypothesis, which assumes that seductive details draw reader's selective attention from critical information. In our study, the alternate antecedent might distract participants from the reinstated antecedents and slow down the recognition times of the reinstated antecedent in the seductive condition.

For the alternate antecedents, however, there were no significant differences in recognition times between the two conditions (i.e., seductive vs. nonseductive). According to the resonance model, seductive alternates should have been encoded more deeply than nonseductive alternates when initially encountered in the text. As a result, the recognition times for the seductive alternates should have been faster than the nonseductive alternates; this did not occur. The results were also inconsistent with the attention distraction hypothesis, which assumes that seductive alternates should receive more attention and should thus be retrieved faster than nonseductive alternates. These discrepancies from previous studies' findings could be due to the fact that our study used short, simple narratives instead of the longer and more complex expository texts used in previous studies of the seductive details effect, or that this study used online measures of reactivation instead of offline recall measures.

In addition, it is important to note that there was no distance effect for all three dependent variables (i.e., reading times, recognition times, and error rates). This was also inconsistent with predictions made by the resonance model and the schema interference hypothesis. According to the resonance model, the late antecedent should be retrieved faster than the early antecedent if both potential antecedents come from the same general class and there are no any other mediating variables (e.g., elaboration). Coincidently, this "order effect" also occurs in one of the explanations of the seductive details effect. As discussed earlier, the schema interference hypothesis (Rey, 2012) assumes that the seductive details effect should be weaker when seductive details are presented after main ideas than when they are presented before main ideas. Again, the passages in the present study were much shorter than the passages used in previous studies of either antecedent retrieval or the seductive details effect, which might be the reason why no distance (order) effect was observed.

The present findings imply that cognitive interest might be another new context-based factor that influences the resonance process besides distance, causality, elaboration, and featural overlap. The results also add to the growing body of literature that supports detrimental effects of seductive details. According to the recognition times for both antecedents (i.e., antecedent and alternate), it is plausible that the seductiveness of an alternate concept might shift readers' attention from a candidate antecedent, which is consistent with the distraction hypothesis (Harp & Mayer, 1998; Rey, 2012). Moreover, the present experiments demonstrate that seductive details have immediate processing consequences, and they extend to narrative texts. An important implication of these findings is that the effects of interesting context may depend on the role it plays in

narratives. If the interesting context in a narrative is nonessential and unimportant information, it would be "seductive" and affect the recall of main ideas, as observed in previous studies. However, if the interesting context in a narrative is essential and important information, it should facilitate the recall of main ideas.

Future studies should replicate this study using other online reading measures such as naming probes or eye tracking technology instead of recognition probes. Recognition probes are frequently used to assess activation levels of concepts, but they also require a binary response; researchers have found that under some conditions, recognition decisions may be influenced by how closely the probe fits with the immediately preceding context (McKoon, & Ratcliff, 2015). In the present study, participants made more errors to alternate than to antecedent probes; this may be consistent with a context checking argument, given that antecedents fit the immediately preceding text (i.e., the reinstatement sentence) better than the alternates. Naming probes, in contrast, are sensitive to semantic priming effects (O'Brien, Duffy, & Myers, 1986; Seidenberg, Waters, Sanders, & Langer, 1984), and are not subject to the same kinds of context checking problems as binary choice response tasks. Eye-tracking technology allows researchers to investigate the time spent processing both potential antecedents during reading. Furthermore, future studies should examine how interest interacts with other variables (e.g., elaboration, causality) to influence the reactivation process and how details in a narrative may either enhance or inhibit processing of more central ideas. For example, would elaborated antecedents fall prey to the seductive details effect in the same way as the present unelaborated antecedents? Or does providing a causal explanation for the seductive detail eliminate (or enhance) its interestingness?

APPENDIX

Sample passage for Experiment

Nonseductive alternate (lion), presented first

Jose was happy to be spending the weekend with his grandparents. There was a zoo in town and there were many animals. Jose's grandparents showed him around. Jose looked into a cage, and in the corner was a curled up **lion**. Jose's grandparents also owned a farm. After looking around the barn, Jose would help his grandfather feed the **sheep**.

Nonseductive alternate (lion), presented second

Jose was happy to be spending the weekend with his grandparents. Jose's grandparents owned a farm. After looking around the barn, Jose helped his grandfather feed the **sheep**. There was also a zoo in town and there were many animals. Jose's grandparents showed him around. Jose looked into a cage, and in the corner was a curled up **lion**.

Seductive alternate (lion), presented first

Jose was happy to be spending the weekend with his grandparents. Jose's grandparents owned a farm. Jose's grandparents showed him around. Jose looked into a stall of the barn, and in the corner was a curled up **lion**. Jose's grandparents owned a pasture, too. After looking around for a while, Jose would help his grandfather feed the **sheep**.

Seductive alternate (lion), presented second

Jose was happy to be spending the weekend with his grandparents. Jose's grandparents owned a pasture. Jose's grandparents showed him around. After looking around for a while, Jose helped his grandfather feed the **sheep**. Jose's grandparents owned a farm, too. Jose looked into a stall of the barn, and in the corner was a curled up **lion**.

Filler

Later that day, Jose's older brother called and wanted to know if he was having a good time. Jose told him all about the adventures he had.

Reinstate the Antecedent

Jose's brother asked him what type of animal he had fed.

Probe Antecedent

Sheep

Probe Alternate

lion

Question
Did Jose's older brother call him later that day?
Yes

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